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A request for correction of the description and claim 3 has been filed pursuant to Rule 88 EPC. A decision on the request will be taken during the proceedings before the Examining Division (Guidelines for Examination in the EPO, A-V, 2.2).

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(54) **Circuit boards.**

(57) A circuit board comprises a sheet (10) which is characterised by a surface (12) carrying electrical circuitry (14) and a layer (18) behind the surface (12) and in heat-conducting communication with it. The layer (18) comprises a mass of diamond or cubic boron nitride particles in a polymeric, metallic or ceramic matrix. The concentration of diamond or cubic boron nitride in the matrix is typically 30 to 60 percent by weight.

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FIG. 1

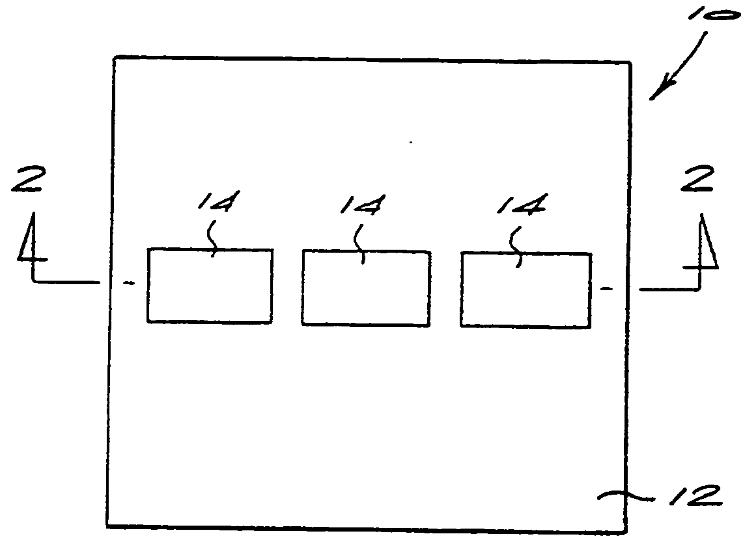
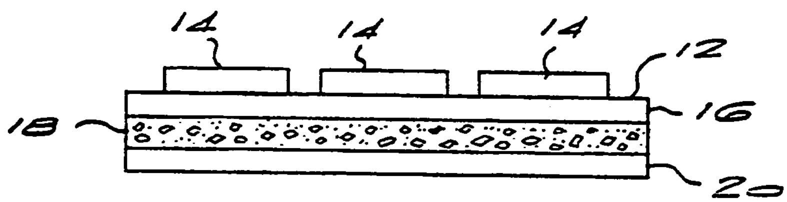


FIG. 2



BACKGROUND TO THE INVENTION

This invention relates to circuit boards.

Substrates for mounting electronics are used in a wide variety of electronic apparatus, e.g. surface mount packages, printed circuit boards etc. Such substrates consist of an electrical circuit formed in the surface of a board which typically consists of several layers. Some of these layers are made of a material or form which conduct heat rapidly away from the surface carrying the circuit. This is necessary because heat is generated in a circuit during use and this heat can be detrimental to the functioning of the circuit or of the electronic device or equipment which utilises the circuit.

SUMMARY OF THE INVENTION

According to the present invention, there is provided a circuit board comprising a self-supporting sheet comprising:

(i) a surface carrying electrical circuitry or an element thereof; and

(ii) a zone behind the surface and in heat-conducting communication with it which comprises a mass of diamond or cubic boron nitride particles in a matrix selected from polymeric, metallic and ceramic, the concentration of the particles in the matrix not exceeding 60 percent by weight.

DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates a plan view of an embodiment of the invention;

Figure 2 is a section along the line 2-2 of Figure 1; and

Figure 3 is a sectional side view of a second embodiment of the invention.

DESCRIPTION OF EMBODIMENTS

The circuit board may be one which carries electrical circuitry on a surface thereof. The circuitry may be printed on the surface or may form part of an integrated chip. The board may also be one which carries an element of such circuitry.

When the matrix is polymeric, it is preferably thermoplastic in nature and may be selected from phenolics, modified phenolics, melamines, polyamides, polyamide-imides, polycarbonates, polysulphanes, acrylonitriles, styrene plastics and olefin polymers.

When the matrix is metallic it may be selected from copper, nickel, molybdenum, aluminium and stainless st el.

When the matrix is ceramic it may b selected from alumina, aluminium nitride, silicon carbide, silicon oxide, silicon nitride, and beryllium oxide. Where the particles are diamond particles and the ceramic matrix is an oxide, it is preferable that the diam nd particles be protected by a suitable coating such as a refractory metal or an oxygenfree ceramic.

The particles of the zone may be diamond or cubic boron nitride. The particles are preferably diamond because of the superior heat conductivity property of diamond. The particles will be more than 2 microns in size. The maximum size of the particles used is dictated by the width or depth of the zone.

The particles are present in the zone in an amount not exceeding 60 percent by weight. The particle content of the zone will preferably be in the range 10 to 60 percent by weight and more preferably 30 to 60 percent by weight.

The zone will generally be in the form of a lay r. One surface of the layer may form the surface which carries the electrical circuitry or element thereof. Alternatively, this layer can be located below this surface and spaced from it by a layer of polymer of the type described above or metal. The two layers will be bonded together.

The sheet is self-supporting in the sense that it can carry the circuitry or element thereof without buckling or bending to any significant extent. The sheet may be rigid or have a certain degree of fexibility.

Embodiments of the invention will now be described with reference to the accompanying drawings. Referring to Figures 1 and 2, there is shown a circuit board comprising a rectangular sheet 10 having a major upper surface 12 on which is mounted a plurality of integrated chips 14.

The sheet 10 comprises three layers 16, 18 and 20 bonded together. The layer 16 is made of a material such as a polymer or metal. The layer 18 comprises a mass of diamond particles in a matrix of the type described above and the layer 20 is made of an insulating or other material. In use, heat generated in the integrated chips passes into the layer 16 and then into the layer 18 from whence it is rapidly conduct d away by virtue of the presence of the highly heat conductive diamond particles in this layer.

Figure 3 illustrates a second embodiment. In this embodiment, the integrated chips 22 are carried on the surface 24 of a sheet 26. The sheet 26 comprises an insulating layer 28 and a second layer 30 bonded thereto. The layer 30 has downwardly depending fins 32 and comprises a mass of diamond particles in a matrix of the type described above. The funs assist in dissipating heat entering the layer 30.

The matrix is preferably polymeric as this reduces the weight of the circuit board. The presence of diamond particles in th range specified abov increases the thermal conductivity of the material 2 to 4 times compared with that of the bas polymer.

In an exampl of the invention, a circuit board was

produced by placing a mixture of diamond particles and a powdered modified phenolic polymer in a mould. The mixture was heated to 60°C and then heated further under the influence of pressure to 175°C. This caused the polymer to melt. The contents of the mould were allowed to cool and the moulded product then removed from the mould.

A rectangular sheet was recovered from the mould. This sheet was selfsupporting and capable of carrying electrical circuitry or an element thereof.

Using this method sheets were produced with diamond particles in the range 20 to 200 microns and concentrations of diamond ranging from 12 to 50 percent by weight.

In order to produce a sheet having a polymer layer between the diamond-containing layer and the surface for carrying the electrical circuitry, a green state mixture of diamond and polymer may first be produced in a mould and then a further layer of diamond-free polymer powder placed on the green state product. The whole is then heated to melt the polymer and form the sheet.

A diamond/metal layer for a circuit board of the invention may be made by making a mixture of the diamond particles and the metal in powdered form, causing a thin layer of this mixture to be deposited on to a support surface, compacting the layer and heat treating the compacted layer under conditions which will not lead to degradation of the diamond particles. Generally, a slurry of the diamond/metal mixture in water will be made, this slurry deposited on the support surface and a major part of the water removed from the slurry before the compaction step. These steps are generally described in European Patent Publication No. 0 294 198.

Claims

1. A circuit board comprising a self-supporting sheet (10) comprising:

   (i) a surface (12) carrying electrical circuitry (14) or an element thereof; and

   (ii) a zone (18) behind the surface (12) and in heat- conducting communication with it which comprises a mass of diamond or cubic boron nitride particles in a matrix selected from polymeric, metallic and ceramic, the concentration of the particles in the matrix not exceeding 60 percent by weight.

2. A circuit board according to claim 1 wherein the polymeric matrix is a thermoplastic polymer.

3. A circuit board according to claim 2 wherein the thermoplastic polymer is selected from phenolics, modified phenolics, melamines, polyamides, polyamide-imides, polycarbonates, polysulphanes, acrylonitriles, styrene plastics and olefin polymers.

4. A circuit board according to claim 1 wherein the matrix is a metallic matrix selected from copper, nickel, molybdenum, aluminium and stainless steel.

5. A circuit board according to claim 1 wherein the matrix is a ceramic matrix and is selected from alumina, aluminium nitride, silicon carbide, silicon oxide, silicon nitride, and beryllium oxide.

6. A circuit board according to any one of the preceding claims wherein the concentration of particles is in the range 10 to 60 percent by weight.

7. A circuit board according to any one of the preceding claims wherein the concentration of particles is in the range 30 to 60 percent by weight.

8. A circuit board according to any one of the preceding claims wherein a layer of a polymeric material (16) is provided between the zone (18) and the surface (12).

9. A circuit board according to claim 8 wherein the zone (18) comprises a layer which is bonded to the polymeric layer (16).

FIG. 1

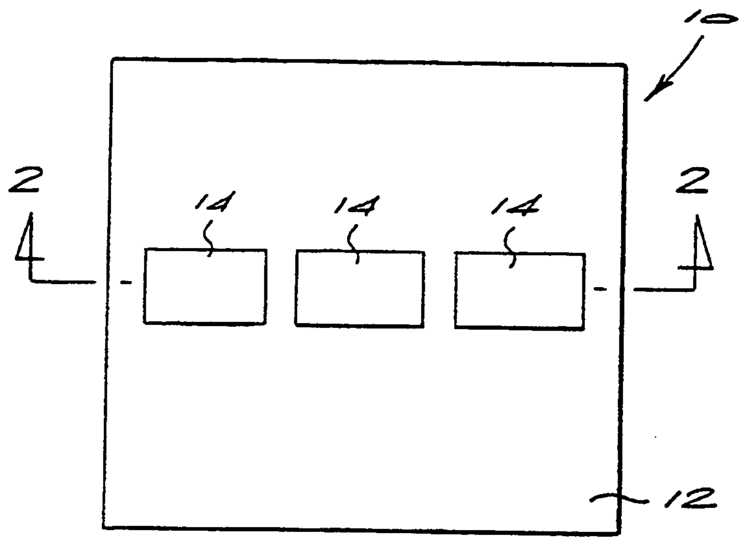
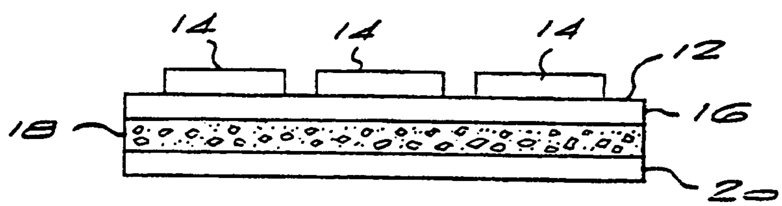


FIG. 2



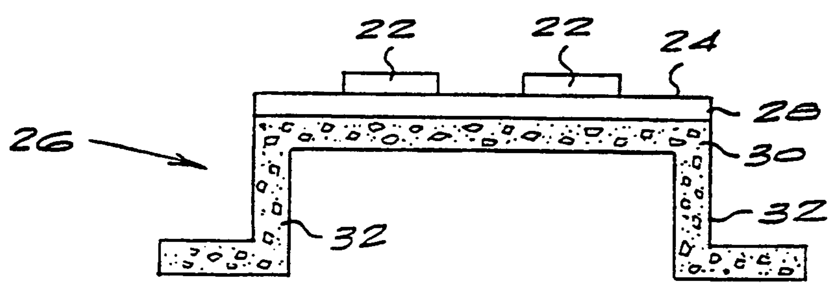


FIG. 3

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(54) Electronic circuit assembly with improved heatsinking

Elektronische Schaltungsanordnung mit verbesserter Hitzeableitung

Assemblage de circuit électronique, comportant des moyens perfectionnés de dissipation thermique

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Description

Background of the Invention

[0001] The present invention relates, in general, to electronic circuit assemblies, and more particularly to electronic circuit assemblies having improved heatsinking capabilities.

[0002] Modern electronic circuit assemblies include high power analog and digital semiconductor devices which inherently generate a great deal of heat. The heat generated by the components must be dissipated during operation in order to maintain acceptable operation temperatures.

[0003] Conventionally, electronic components are mounted on printed circuit boards. Printed circuit boards are not good heatsinks, but provide the electrical insulation necessary for electronic circuit operation, and provide a substrate for printed circuits connecting the various components. In order to dissipate heat, the conventional printed circuit boards are typically mounted on metal, e.g. copper, heatsinks which will draw the heat from the circuit board.

[0004] In analog electronics, as frequencies and power increase as required by modern telecommunications for example, the above described heatsinking arrangement is not sufficient to maintain operable temperatures. The same problem arises in digital electronics for example with high performance microprocessors. A prior art solution is to isolate the particular components generating the most heat, and attach them separately to the metal heatsink which lies below the printed circuit board. This is accomplished by providing an opening through the printed circuit board, the opening accessing the metal heatsink.

[0005] The heat generating component can not be attached directly to the metal heatsink because it must be attached to an electrically insulating substrate. Consequently, the heat generating component is first attached to a ceramic substrate. The ceramic substrate is then attached to the metal heatsink, through the opening in the printed circuit board. For example, see Japanese patent application no. JP-A-61-214455. As another example, see pages 36, 494 and 512-513 of "Microelectronics Packaging Handbook" edited by R. Tummala et al. and published by Van Nostrand Reinhold in 1988.

[0006] The prior art solution gives rise to particular disadvantages. For example, the ceramic substrate between the heat generating component and the heatsink does not dissipate heat particularly well. Ceramics have approximately 1/100 the heat dissipation ability compared to copper. Consequently, although operable temperatures can be maintained, there will be localized heat gradients, the heat being high near the heat generating component mounted on the ceramic substrate. This leads to problems such as metal migration, which eventually results in device failure.

[0007] Additionally, beryllium oxide is typically used as the ceramic substrate because it has fairly good heat dissipating characteristics. However, beryllium oxide gives rise to toxic substances during processing. Furthermore, since the ceramic connecting the heat generating component through the heatsink is not a particularly good heat dissipater, the electronic component itself must be designed to dissipate heat as efficiently as possible. Typically, the electronic component is a semiconductor die. In order to provide efficient heat dissipation, the semiconductor die is often thinned to as little as 0.13 mm (5 mils). The thinning leads to a more fragile device and requires extra processing, and therefore negatively impacts cost and yield.

[0008] European patent applications nos. EP-A-0479205 and EP-A-0435603 both disclose assemblies that use diamond layers for heat dissipation.

[0009] What is needed is an electronic circuit assembly with improved heatsinking which overcomes the disadvantages of the prior art. Specifically, a heatsinking arrangement is needed which conducts heat efficiently and uniformly, while providing electrical insulation without the need for an extra ceramic substrate. Additionally, it would be desirable to provide enough heat dissipation so that the heat generating component does not need to be thinned.

Summary of the Invention

[0010] Briefly stated, the present invention overcomes the disadvantages of the prior art by providing an electronic circuit assembly with improved heatsinking capabilities as recited in claim 1 of the accompanying claims.

[0011] A method for making an electronic circuit assembly with improved heatsinking in accordance with the present invention is also disclosed and claimed in the accompanying claims.

[0012] The term "diamond", as used to describe materials associated with the invention, is intended to mean substantially diamond.

Brief Description of the Drawings

[0013]

FIG. 1 is a perspective view of a simplified exemplary electronic circuit assembly;

FIG. 2 is a simplified cross-section of an electronic circuit assembly of the prior art;

FIG. 3 is a simplified cross-section of an electronic circuit assembly in accordance with the present invention;

FIG. 4 is a simplified cross-section of an alternate embodiment of an electronic circuit assembly in accordance with the present invention; and

FIG. 5 is a simplified cross-section of yet another embodiment of an electronic circuit assembly in

accordance with the present invention.

Detailed Description of the Drawings

[0014] FIG. 1 is a perspective view of electronic circuit assembly 10. Circuit assembly 10 is a simplified exemplary assembly. Circuit assembly 10 includes component carrying board 12, which is typically a printed circuit board comprising an insulating board and conductive traces connecting the various components (not shown). Components 14, 16, 18, 20 and 22 represent the electronic components comprising the circuit. Components 14 and 16 represent surface mount integrated circuits. Components 18 and 20 represent chip resistors and chip capacitors. Component 22 is the heat generating component. Heat generating component 22 may be a high frequency analog device or a microprocessor, for example. Note that wires 23, 25, 27 and 29 represent wirebonded connections between component 22 and the rest of the circuit. Alternatively, component 22 could be a packaged device electrically connected to the rest of the circuit with patterned traces.

[0015] Circuit assembly 10 further includes heatsinking layer 24 disposed on the bottom surface of printed circuit board 12. In the prior art, heatsinking layer 24 would comprise a copper substrate. Additionally, heat generating component 22 would be mounted to a ceramic substrate (not shown), and attached to heatsinking layer 24 through opening 26 in printed circuit board 12. Opening 26 is sized to receive component 22.

[0016] In contrast, in accordance with the present invention, heatsinking layer 24 comprises a diamond layer. Additionally, heat generating component 22 is mounted directly to diamond layer 24. Both the prior art approach and the assembly in accordance with the present invention are discussed in further detail below.

[0017] FIG. 2 is a highly simplified cross-section of a prior art circuit assembly 30. Circuit assembly 30 comprises component carrying board 32, which is typically a printed circuit board. Printed circuit board 32 comprises opening 34. Opening 34 is sized to receive electronic component 36 which is attached to ceramic substrate 38. Typically, electronic component 36 comprises a semiconductor die and ceramic substrate 38 comprises a beryllium oxide substrate. Both board 32 and ceramic substrate 38 are attached to metal heatsink 40. Metal heatsink 40 typically comprises a copper substrate. In practice, circuit assembly 30, with copper substrate 40, would be mounted in a piece of electronic equipment such as a computer or portable telephone. Copper layer 40 would typically be screwed to a back plane to further distribute the heat away from the electronic circuit.

[0018] FIG. 3 is a highly simplified cross-section of a electronic circuit assembly in accordance with the present invention. FIG. 3 represents the preferred assembly, while FIGs. 4 and 5 represent alternative assemblies in accordance with the present invention. Referring to FIG. 3, a first diamond layer 50 is provided. Diamond layer 50 is preferably a polycrystalline diamond slab, 0.25 mm - 0.76 mm (10-30 mils) in thickness. Diamond layer 50 is formed with a commercial chemical vapor deposition (CVD) process and available from Diamonex™ Inc. Diamond layer 50 may alternatively comprise amorphous diamond or single crystalline diamond. In alternative embodiments, detailed below, diamond layer 50 may also comprise deposited thin film.

[0019] Diamond layer 50 is sputter deposited with a metal layer capable of interacting with carbon. The preferred metal is tungsten. Referring to FIG. 3, when tungsten is sputtered on diamond layer 50, a tungsten carbide layer 52 forms beneath a tungsten layer 54. Tungsten layer 54 provides a surface which will adhere to solder, for connecting the remainder of the circuit assembly, as will be described. It will be understood that other metals capable of forming metal carbon compounds may be substituted for the sputtered tungsten. In the preferred embodiment, approximately 100-500 nm of tungsten is deposited.

[0020] The circuit assembly further comprises component carrying board 56. Component carrying board 56 is a printed circuit board. Board 56 comprises a first surface which is bottom surface 58. Bottom surface 58 opposes a second surface which is top surface 60. Board 56 further comprises opening 62 extending from top surface 60 to bottom surface 58. Opening 62 is sized to receive electronic component 64 which, in the preferred embodiment, comprises a semiconductor die. It will be understood that board 56 may comprise several of such openings as required by other heat generating electronic components.

[0021] Semiconductor die 64 attaches to diamond layer 50 through opening 62. More specifically, semiconductor die 64 has a bottom surface 66 which is attached to layer 50 with a first material layer 68 comprising a first solder. Since diamond layer 50 has been covered with tungsten layer 54, layer 68 will adhere to diamond layer 50 by way of tungsten layer 54.

[0022] Similarly, bottom surface 58 of board 56 is covered with a second material layer 70, comprising a second solder.

[0023] In a preferred method for forming a circuit assembly in accordance with the present invention, semiconductor die 64 is attached to diamond layer 50 before board 56 is attached to diamond layer 50. More specifically, semiconductor die 64 is attached to diamond layer 50 in a location corresponding to opening 62 in board 56. Solder layer 68 is heated to an appropriate temperature to provide reflow and thus attach semiconductor die 64 to diamond layer 50. Subsequently, board 56 is mated to diamond layer 50 in a like manner. Opening 62 surrounds semiconductor die 64.

[0024] In the preferred embodiment, first solder layer 68 covering the bottom surface of semiconductor die 64 comprises tin antimony. Tin antimony has a rela-

tively high reflow temperature. In contrast, second solder layer 70 covering bottom surface 58 of board 56 comprises a lower temperature solder, such as tin lead. In a method for producing a circuit assembly in accordance with the present invention, semiconductor die 64 is attached first by reflowing at its solder's higher temperature. Subsequently, board 56 can be attached by reflowing at a lower temperature. The difference in solder reflow temperature therefore permits semiconductor die 64 to remain aligned and undisturbed when board 56 is attached to diamond layer 50.

[0025] In the preferred embodiment, semiconductor die 64 is approximately 0.38 mm - 0.51 mm (15-20 mils) thick. This thickness is intended to be the thickness of the die after it has been fabricated. Because diamond layer 50 provides such an efficient heatsink, semiconductor die 64 does not need to be thinned, as required by the prior art. Thus, processing steps are eliminated, and yield is improved.

[0026] Preferably, board 56 is constructed to be approximately the same thickness as semiconductor die 64. Consequently, top surface 72 of semiconductor die 64 is level with top surface 60 of board 56. Furthermore, bottom surface 66 of semiconductor die 64 is level with bottom surface 58 of board 56. Bottom surface 66 of semiconductor die 64 thus lies in a plane defined by bottom surface 58 of board 56. Because semiconductor die 64 does not need to be thinned and is the same thickness as board 56, processing is significantly simplified. Furthermore, the need for an extra ceramic substrate, with associated costs and extra processing, is eliminated.

[0027] An alternative embodiment is illustrated by FIG. 4. FIG. 4 is a simplified cross-section of a circuit assembly in accordance with the present invention. The same reference numerals designate analogous portions of the electronic circuit assembly. The embodiment shown in FIG. 4 permits the use of prethinned die, and therefore may use die which were designed for use with the extra ceramic substrate of the prior art.

[0028] One notable difference between the embodiment of FIG. 4 and the embodiment of FIG. 3 is that, in the embodiment of FIG. 4, diamond layer 51 further comprises a first portion 80 extending into opening 62. First portion 80 insulatingly contacts bottom surface 66 of semiconductor die 65. Diamond layer 51 is provided and prepared with a metal carbon compound and metal layer for adhering to solder from the bottom of board 56 and semiconductor die 64, as described earlier. Alternatively, in the present embodiment, diamond layer 51 may be deposited amorphous or polycrystalline diamond. Acceptable methods of chemical deposition of diamond are disclosed, for example, in United States Patent Nos. 5,124,179 and 5,126,206, which are incorporated herein by reference.

[0029] FIG. 5 illustrates another alternative embodiment in accordance with the present invention. FIG. 5 is a simplified cross-section of a circuit assembly comprising elements analogous to those of the embodiment shown in FIG. 3. A notable difference in the embodiment of FIG. 5 is the second diamond layer 90 covering the top surface 60 of the board 56. Second diamond layer 90 preferably comprises a conformal coat of diamond-like carbon film (DLC). Second diamond layer 90 is preferably formed on board 56 with a low pressure CVD process or an ion sputter process, commercially available from, for example, Diamonex™ Inc. It will be understood that layer 90 conformally coats the components, wires, traces, and the like which may be disposed on top surface 60 of board 56.

[0030] By now it will be appreciated that an electronic circuit assembly with improved heatsinking is provided by the present invention. The use of a diamond layer in the place of conventional metal heatsinks provides heatsinking and an insulating surface simultaneously. Consequently, the need for a ceramic substrate interfacing a heat generating component to a heatsink is eliminated. Furthermore, because diamond conducts heat approximately five times as efficiently as the conventional copper, heat is distributed uniformly throughout the diamond layer in accordance with the present invention. Additionally, where the heat generating electronic component is a semiconductor die, it does not need to be thinned after processing because heat can be dissipated sufficiently with a die having its normal thickness.

Claims

1. An electronic circuit assembly with improved heatsinking, comprising:

   a component board (56) comprising a first surface (58), a second surface (60), and at least one opening (62) extending from the first surface (58) to the second surface (60);
   a first diamond layer (50, 51) adjacent to the first surface (58) of the component board (56);
   a first metallic layer (52) consisting of a metal carbon compound and located between the first diamond layer (50,51) and the first surface (58) of the component board (56);
   a second metallic layer (54) consisting of the metal of said compound
   and located between the first metallic layer (52) and the first surface (58) of the component board (56);
   an electronic component (64, 65) in the at least one opening (62) and overlying the second metallic layer (54); and
   a first solder (68) between the second metallic layer (54) and the electronic component (64, 65),
   wherein heat is dissipated from the electronic component (64, 65) to the first diamond layer (50, 51) and distributed throughout the dia-

mond layer (50, 51).

2. The assembly of claim 1 wherein a first portion (80) of the first diamond layer (51) extends into the opening (62) to meet the electronic component (65).

3. The assembly of claims 1 or 2 further comprising a second solder (70) between the second metallic layer (54) and the component board (56), the first solder (68) having a higher melting temperature than the second solder (70).

4. The assembly of claims 1, 2, or 3 further comprising a second diamond layer (90) physically contacting the electronic component (64).

5. The assembly of claims 1, 2, 3, or 4 wherein the metal comprises tungsten.

6. The assembly of claims 1, 2, 3, or 4 wherein the metal carbon compound comprises tungsten carbide.

7. A method for making an electronic circuit assembly with improved heatsinking, comprising the steps of:

   providing a first diamond layer (50);
   sputtering a metal over the first diamond layer (50), whereby said metal reacts with carbon of the first diamond layer (50) to form a first layer (54) comprised of the metal overlying a second layer (52) comprised of a metal carbon compound;
   providing an electronic component (64, 65) having a bottom surface (66);
   coupling the bottom surface (66) of the electronic component (64, 65) to the first layer (54) with a first material (68), wherein the first material (68) is solder;
   providing a component board (56) having a first surface (58) opposite a second surface (60), and an opening (62); and
   coupling the component board (56) to the first layer (54) such that the opening (62) surrounds the electronic component (64, 65).

8. The method of claim 7 wherein the step of coupling the bottom surface (66) of the electronic component (64, 65) occurs at a higher temperature than the step of coupling the component board (56).

9. The method of claims 7 or 8 wherein the step of coupling the bottom surface (66) of the electronic component (64, 65) includes providing a first solder for the first material (68) and wherein the step of coupling the component board (56) includes using a second solder (58) to couple th component board (56) to the first layer (54), the second solder different from the first solder.

10. The method of claims 7, 8, or 9 further comprising the step of conformally covering the opening (62) and the electronic component (64) with a second diamond layer (90).

Patentansprüche

1. Elektronische Schaltungsanordnung mit verbesserter Wärmeableitung, mit:

   einer Komponentenkarte (56) mit einer ersten Oberfläche (58), einer zweiten Oberfläche (60) und wenigstens einer Öffnung (62), welche sich von der ersten Oberfläche (58) zur zweiten Oberfläche (60) erstreckt;
   einer ersten Diamantschicht (50, 51), welche der ersten Oberfläche (58) der Komponentenkarte (56) benachbart ist; einer ersten Metallschicht (52), welche aus einer Metall-Kohlenstoff-Verbindung besteht und zwischen der ersten Diamantschicht (50, 51) und der ersten Oberfläche (58) der Komponentenkarte (56) angeordnet ist;
   einer zweiten Metallschicht (54), welche aus dem Metall der Verbindung besteht und zwischen der ersten Metallschicht (52) und der ersten Oberfläche (58) der Komponentenkarte (56) angeordnet ist;
   einer elektronischen Komponente (64, 65) in der wenigstens einen Öffnung (62), wobei diese über der zweiten Metallschicht (54) liegt; und
   einem ersten Lötmittel (68) zwischen der zweiten Metallschicht (54) und der elektronischen Komponente (64, 65),
   wobei Wärme von der elektronischen Komponente (64, 65) zur ersten Diamantschicht (50, 51) abgeleitet und durch die Diamantschicht (50, 51) verteilt wird.

2. Anordnung nach Anspruch 1, bei der sich ein erster Abschnitt (80) der ersten Diamantschicht (51) in die Öffnung (62) erstreckt, um mit der elektronischen Komponente (65) zusammenzutreffen.

3. Anordnung nach Anspruch 1 oder 2, welche weiterhin ein zweites Lötmittel (70) zwischen der zweiten Metallschicht (54) und der Komponentenkarte (56) umfasst, wobei das erste Lötmittel (68) eine höhere Schmelztemperatur als das zweite Lötmittel (70) aufweist.

4. Anordnung nach Anspruch 1, 2 oder 3, welche weiterhin eine zweite Diamantschicht (90) aufweist, w lche die elektronische Komponente (64) physi-

kalisch kontaktiert.

5. Anordnung nach Anspruch 1, 2, 3 oder 4, bei der das Metall Wolfram umfasst.

6. Anordnung nach Anspruch 1, 2, 3 oder 4, bei der die Metall-Kohlenstoff-Verbindung Wolframcarbid umfasst.

7. Verfahren zum Herstellen einer elektronischen Schaltungsanordnung mit verbesserter Wärmeableitung, wobei dieses die Schritte aufweist:

   Vorsehen einer ersten Diamantschicht (50);
   Sputtern eines Metalls über die erste Diamantschicht (50), wobei das Metall mit Kohlenstoff der ersten Diamantschicht (50) reagiert, um eine erste Schicht (54) zu bilden, welche das Metall umfasst und über einer zweiten Schicht (52) liegt, welche eine Metall-Kohlenstoff-Verbindung umfasst; Vorsehen einer elektronischen Komponente (64, 65) mit einer unteren Oberfläche (66);
   Koppeln der unteren Oberfläche (66) der elektronischen Komponente (64, 65) mit der ersten Schicht (54) mit einem ersten Material (68), wobei das erste Material (68) ein Lötmittel ist;
   Vorsehen einer Komponentenkarte (56) mit einer ersten Oberfläche (58) gegenüber einer zweiten Oberfläche (60) und einer Öffnung (62); und
   Koppeln der Komponentenkarte (56) mit der ersten Schicht (54), sodass die Öffnung (62) die elektronische Komponente (64, 65) umgibt.

8. Verfahren nach Anspruch 7, bei dem der Schritt des Koppelns der unteren Oberfläche (66) der elektronischen Komponente (64, 65) bei einer höheren Temperatur auftritt als der Schritt des Koppelns der Komponentenkarte (56).

9. Verfahren nach Anspruch 7 oder 8, bei dem der Schritt des Koppelns der unteren Oberfläche (66) der elektronischen Komponente (64, 65) das Vorsehen eines ersten Lötmittels als das erste Material (68) enthält und bei dem der Schritt des Koppelns der Komponentenkarte (56) die Verwendung eines zweiten Lötmittels (58) zum Koppeln der Komponentenkarte (56) mit der ersten Schicht (54) enthält, wobei sich das zweite Lötmittel von dem ersten Lötmittel unterscheidet.

10. Verfahren nach Anspruch 7, 8 oder 9, welches weiterhin den Schritt aufweist, die Öffnung (62) und die elektronische Komponente (64) mit einer zweiten Diamantschicht (90) konturgetreu zu überziehen.

Revendications

1. Assemblage de circuit électronique à dissipation thermique améliorée, qui comprend :

   une carte de composants (56), comprenant une première surface (58), une deuxième surface (60) et au moins une ouverture (62) qui s'étend de la première surface (58) à la deuxième surface (60) ;
   une première couche de diamant (50, 51) adjacente à la première surface (58) de la carte de composants (56) ;
   une première couche métallique (52) consistant en un composé métalcarbone et placée entre la première couche de diamant (50, 51) et la première surface (58) de la carte de composants (56) ;
   une deuxième couche métallique (54) consistant en le métal dudit composé et étant placée entre la première couche métallique (52) et la première surface (58) de la carte de composant (56) ;
   un composant électronique (64, 65) placé dans ladite ouverture (62) et s'étendant au-dessus de ladite deuxième couche métallique (54) ; et
   une première soudure (68) placée entre la deuxième couche métallique (54) et le composant électronique (64, 65),
   où de la chaleur est dissipée du composant électronique (64, 65) vers la première couche de diamant (50, 51) et est répartie dans toute la couche de diamant (50, 51).

2. Assemblage selon la revendication 1, où une première partie (80) de la première couche de diamant (51) s'étend jusque dans l'ouverture (62) de façon à rencontrer le composant électronique (65).

3. Assemblage selon la revendication 1 ou 2, comprenant en outre une deuxième soudure (70) placée entre la deuxième couche métallique (54) et la carte de composants (56), la première soudure (68) ayant une température de fusion plus élevée que la deuxième soudure (70).

4. Assemblage selon la revendication 1, 2 ou 3, comprenant en outre une deuxième couche de diamant (90) disposée en contact matériel avec le composant électronique (64).

5. Assemblage selon la revendication 1, 2, 3 ou 4, où le métal comprend le tungstène.

6. Assemblage selon la revendication 1, 2, 3 ou 4, où le composé métal-carbone comprend le carbure de tungstène.

7. Procédé de fabrication d'un assemblage de circuit électronique ayant une dissipation thermique améliorée, le procédé comprenant les opérations suivantes :

prévoir une première couche de diamant (50) ;
pulvériser un métal sur la première couche de diamant (50), de sorte que ledit métal réagit avec le carbone de la première couche de diamant (50) de façon à former une première couche (54) constituée du métal placé au-dessus d'une deuxième couche (52) constituée d'un composé métal-carbone ;
prévoir un composant électronique (64, 65) ayant une surface de dessous (66) ;
coupler la surface de dessous (66) du composant électronique (64, 65) à la première couche (54) au moyen d'une première matière (68), où la première matière (68) est une soudure ;
prévoir une carte de composants (56) qui possède une première surface (58), opposée à une deuxième surface (60), et une ouverture (62) ; et
coupler la carte de composants (56) à la première couche (54) de façon que l'ouverture (62) entoure le composant électronique (64, 65).

8. Procédé selon la revendication 7, où l'opération de couplage de la surface inférieure (66) du composant électronique (64, 65) a lieu à une température supérieure à celle de l'opération de couplage de la carte de composants (56).

9. Procédé selon la revendication 7 ou 8, où l'opération de couplage de la surface inférieure (66) du composant électronique (64, 65) comporte la fourniture d'une première soudure pour la première matière (68) et où l'opération de couplage de la carte de composants (56) comporte l'utilisation d'une deuxième soudure (58) servant à coupler la carte de composants (56) à la première couche (54), la deuxième soudure étant différente de la première soudure.

10. Procédé selon la revendication 7, 8 ou 9, comprenant en outre l'opération qui consiste à recouvrir de manière conforme l'ouverture (62) et le composant électronique (64) au moyen d'une deuxième couche de diamant (90).

FIG. 1

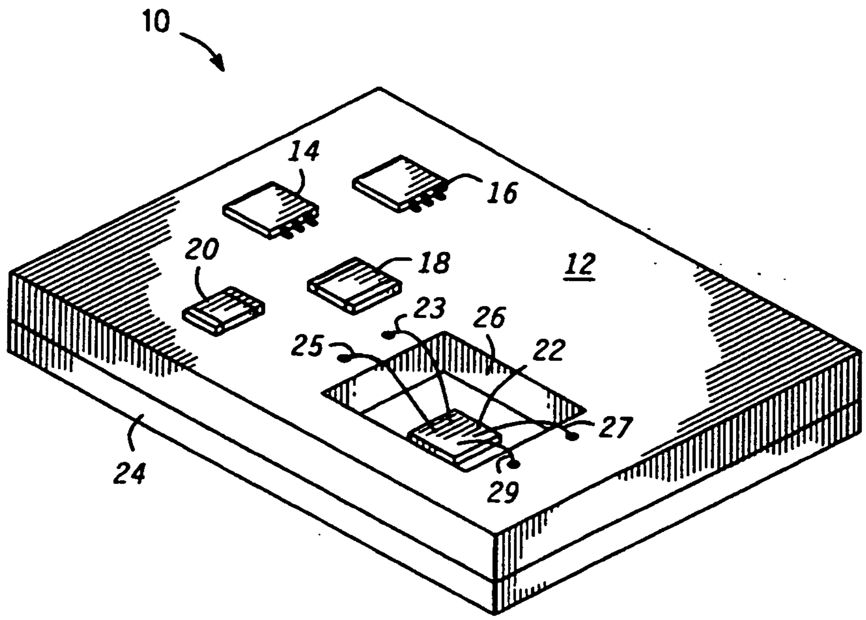


FIG. 2
(PRIOR ART)

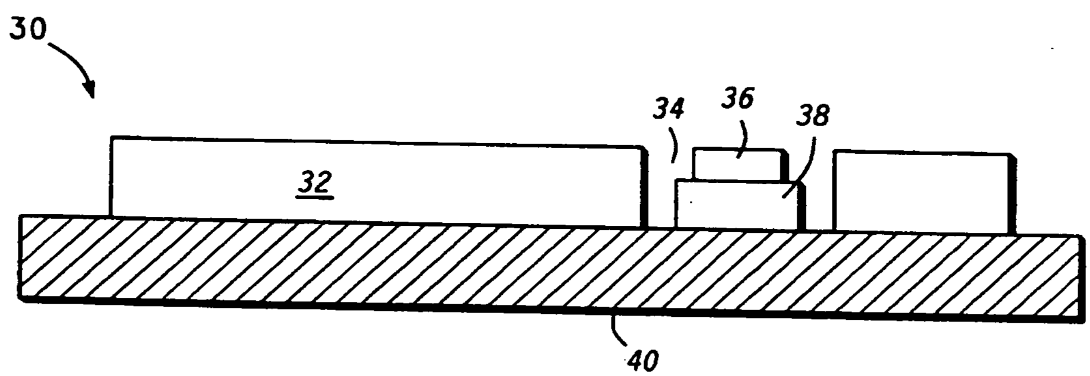


FIG. 3

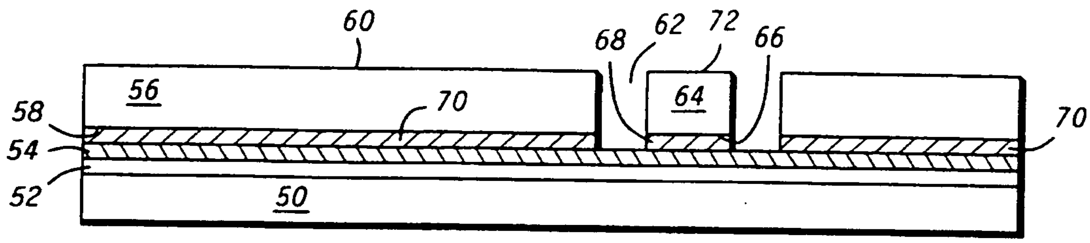


FIG. 4

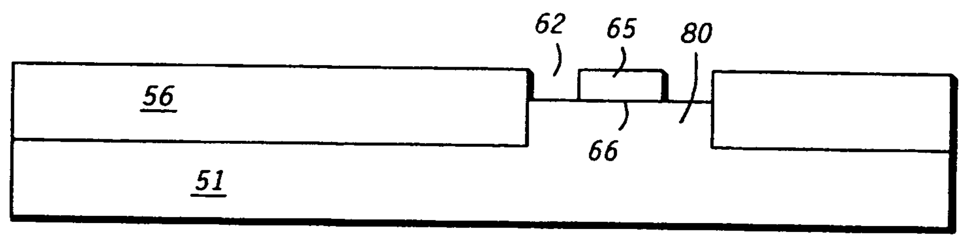
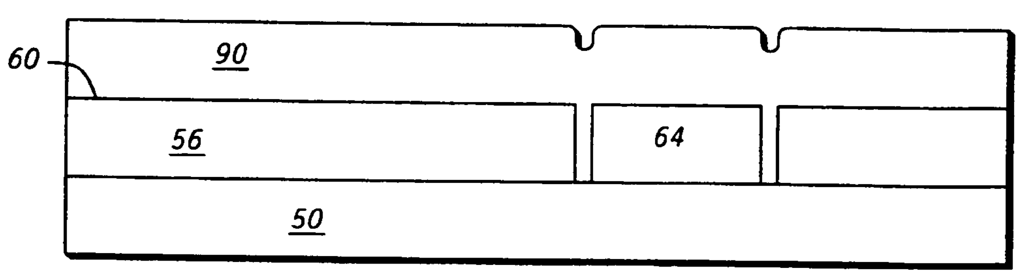


FIG. 5



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(71) Applicant: **SUMITOMO ELECTRIC IND LTD**

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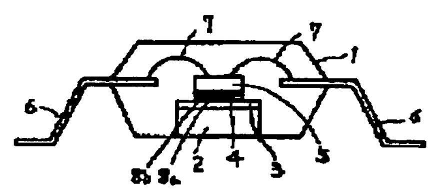
(54) **HEAT SINK**

(57) Abstract:

PROBLEM TO BE SOLVED: To improve a heat sink in thermal conductivity as a whole by a method, wherein all the one surface of a metal board of comparatively satisfactory thermal conductivity is covered with a polycrystalline diamond layer of a specified thickness.

SOLUTION: A semiconductor element 5, bonding wires 7 connected to the semiconductor element 5, and a lead frame 6 connected to the bonding wires 7 are provided inside a package 1. A metal board material 2, a polycrystalline diamond layer 3, a first intermediate bonding layer 8a, a second intermediate bonding layer 8b, and a metal bonding layer 4 are provided in this order starting from the bottom to serve as a base for the semiconductor element 5. At this point, a metal board material 2 (0.5 mm in thickness, 2 inches in diameter) is formed of a sintered nonmetallic element selected from among Si, AlN, SiC, Si_3N_4, or the like, and a polycrystalline diamond layer 3 is formed as thick as 50 μm on the metal board material 2 through a hot filament CVD method. The CVD method is carried out under the conditions, where material gas is composed of 1,500 sccm hydrogen and 30 sccm methane, gas pressure is set at 70 Torr, a W filament temperature is set at 2,000 to 2,100°C, and the time is set at 45 hours.



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ÖSTERREICHISCHES PATENTAMT

Recherchenbericht zu GM 629/2002

Klassifikation des Anmeldungsgegenstands gemäß IPC[7]:
H 01 L 23/373, H 01 L 21/48, H 05 K 1/03

Recherchierter Prüfstoff (Klassifikation):
H 01 L, H 05 K

Konsultierte Online-Datenbank:
WPI, EPODOC, PAJ, NPL

Dieser Recherchenbericht wurde zu den **am 19.09.2003 eingereichten** Ansprüchen erstellt.
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Kategorie*)	Bezeichnung der Veröffentlichung: Ländercode*), Veröffentlichungsnummer, Dokumentart (Anmelder), Veröffentlichungsdatum, Textstelle oder Figur soweit erforderlich	Betreffend Anspruch
A	EP 0 450 968 A2 (De Beers Industiral Diamond Division) 9. Oktober 1991 (09.10.91) Zusammenfassung, Spalte 1 Zeilen 20-30, Spalte 1 Zeilen 54-56, Spalte 2 Zeile 17, Spalte 2 Zeilen 36-37, Figuren 1,2 und die dazugehörigen Beschreibungen	1-8
A	EP 0 637 076 A2 (Motorola INC.) 1. Feber 1995 (01.02.95) Zusammenfassung, Abbildung 3 und die dazugehörige Beschreibung	1-8
A	JP 11243168 A (Sumitomo Electric Industries) 22. Dezember 1999 (22.12.99) (Zusammenfassung). [online] [abgefragt am 24/09/2003]. Recherchiert in: EPOQUE PAJ Datenbank Zusammenfassung	1-8

Datum der Beendigung der Recherche:	Prüfer(in):
24. September 2003	Dipl.-Ing. KÖGL

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